

Stochastic Hydrology of the Great Lakes – A Systematic Analysis

Review comments of Paul Whitfield

General Comments:

While I expect the intention of this document was to make the material less technical and more accessible for a wider readership than the original documents, it pretty much fails. This is pretty much as do-it-yourself interpretation.

It is never clearly stated who the readers of this report will be. As such I have allowed my scientific perspective to be the basis for my assessment. If the readers will be high-end statistical hydrologists then the report will need some additional work. If the readers do not have extensive statistical knowledge and experience the report will need much improvement in many areas.

Nowhere in Parts A to C did I feel that I was provided sufficient background, context, or criteria that I would come to a conclusion about the adequacy of the model output without relying heavily on my personal experience. The presentation is not well structured and there are many items [see detailed comments below] that are exclusionary – such as encoded figure titles. A more general reader would likely be overwhelmed by the report, and either baffled or intimidated. This is simply not acceptable.

Part D was much easier to follow as written as the technical details was there to support, but this part would remain inaccessible to a more general reader. There were also many 'overstated' premises that give me cause for concern.

It would have been useful for the reviewer to have line numbers in addition to page numbers.

Did anyone read this 'manuscript' over before it was sent out for review? It is full of spelling errors and split tables and captions lost to successive pages. Also, figure and table references that are many pages distant.

In many, many places, the report is written as a series of pointers to figures without any support for content or context. The gravest examples of this are in Part C where each chapter is basically a list of plots, with the plots but with no explanation and no interpretation. Was this intended to be some form of do-it-yourself interpretation?

It would be better if the framework was more like:

- In this section we assess *something*.

- This *something* is relevant to our problem because ... With logical reasoning explained.
- We assess/test this *something* in the following way
- The assumptions of this are ...
- In figure xx the *something* is shown and because of context the reader can see that
- Our interpretation of this is that *something* is ...

In summary we show that *something* is true/false because ...

There are inconsistencies in the numbering of tables and figures with the text using one system and the figures/tables numbered differently. Many figures and tables are not actually written about in the text. Captions of figures and tables could be improved to the information the reader needs available [particularly if it continues to be do-it-yourself interpretation]. Many figures and tables retain encoded information that I assume is more to do with file and image management than provision of information to the reader.

Specific Comments:

Editor's note:

Page ii. "The peer review was conducted under the joint auspicious of National Academy of Sciences in the US and the Royal Society of Canada." – is this in fact true?

Global page numbers are used throughout.

Page 2. The statement "The IJC, created by the Boundary Waters Treaty of 1909, has the responsibility to manage the shared waters between Canada and the United States." Is not consistent with my experience and understanding of the IJC.

Page 3. The section "Approaches and Products" is quite useful to help understand the perspective of the document, but it does not provide a sufficient description. While the pluses of choices that were made seem to be well noted, these choices also have minuses which are not described at all. The group has made choices, and I understand that they were unable to examine every potentiality. However, there are many places that a person who is not experience in these areas is not provided with sufficient detail. In each and every section it would be useful to state why a choice was made and the consequences. For example, they group chose NCEP variables, but does not provide the grid size, or acknowledge that the precipitation fields are known to be poor. They also chose Scenarios A1B and A2 for future climates without

If I understand correctly, the references have been previously published and the components of this are 'extractions' from those reports. It is unclear if the context section will persist past this review, but it should be, and the 'components' should come before the references.

Seidou reference – extra text could be removed. Taesam should be T. and K1N6N5 is a postal code?

Part A Statistical Characteristics of the Historical Data Base.

General Comments.

This will be a useful part of the report once the many shortcomings are addressed. It is useful to provide the context and background from which the studies were built upon. My impression is that this is a cut and paste from other documents that has been given insufficient attention.

Throughout this component there is far too much left to the reader's experience or imagination. Some of these are addressed in the details below, but in revision, the authors should take care to make clear the myriad of details that frequently are assumed to be known.

Detailed comments

Introduction.

Net Basin Supply should be defined when it is first referred to and also the use of 'NBS' established. There are two methods component and residual and in sentence 2 of the introduction the term residual method is mentioned but not explained. I presume that the entire component deals only with residual net basin supply?

A one paragraph introduction is insufficient. It presumes the reader has extensive previous experience with these studies which might be fair if the readership was clearer.

Great Lakes Hydrology onwards.

I suggest that this section be reorganized. It would be more logical, in my opinion, if the component started with a more thorough description of the seasonal hydrology of the lakes [Figures 27-31].

Great Lakes Hydrology: This paragraph seems insufficient to describe the scope of the presentation that follows. In the last sentence the word 'justify' does not seem suitable.

Annual Characteristics

This is an incorrect title. What the section describes is the characteristics of the series of annual NBS and not the 'Annual Characteristics'.

Line 3 change 'or' to 'and'

This section is not sufficiently complete. Figure 1 to 5 are not adequately presented nor fully used. An experienced statistician would be fine, but there really needs to be more detail provided. If you are not going to use all parts of the figure then do not present them. It seems that only the left hand column are used, and even those are not adequately explained. The captions to the figures are inadequate. They should describe how each panel was prepared; presently too much is left to the reader to guess. I suggest they be labelled a-f and not referred to as 'the mid portion of the left figures' .

Figures 1-5.

The title is unclear. While assume that 'superior20100511' helps identify the file, it does not help the reader "Lake Superior NBS" would be better. "Annual Portrait of Historical Series" is not an appropriate subtitle and can be deleted.

Label the parts [a] to [f]

[a] The axes need to be better labelled. In panel a, the y axis is Net Basin Supply. Check that the units are actually m^3/s and not Millions of m^3/sec ?

[b] The axes need to be explained. One of them should be NBS, the other cumulative probability. Need to explain what "Hilbert = 0.995" contributes. Perhaps in the caption? Some use of this panel should be made in the text, of the [b]s can be removed.

[c] When one considers long term persistence and connection with the climate system, why is 10 years sufficient? I would have expected this to cover a much longer period of years.

[d] Needs to be described in the caption and used in the text. Presently, it could be completely eliminated as it is not mentioned. It is clear that some degree of smoothing has been applied, but that information is not provided.

[e] This is largely a repeat of panel [a] so the same comment about the y axis applies. The caption should indicate which curve applies to which axis. It would also be useful to indicate the 'critical level' for the change point probability.

[f] No mention is made of these panels in the text. The caption should indicate thick and thin in addition to colour.

Panels [b, f, and d] are not mentioned in the text that followed in the document; perhaps they should simply be removed.

Page 7. This section is pretty unclear. Lake Superior does not show a change, the lower lakes show non-synchronous changes. The presentation does not make that sufficiently clear and this page is particularly awkward.

In the first sentence three Lakes are mentioned, but the second sentence refers to both lakes.

In the last sentence, suggest that you delete 'definitively'. If they are definitely not present you need to supply a reference.

Para 2. ACF with lag of ten is not sufficient for a series of annual values where long term persistence may exist.

Para 3: is this useful if it only identifies one shift; and the three shifts are not synchronous, One shift about 1940, one about 1965 and the other around 1970. It seems that these are really important but not adequately presented here. Other references, considering climate system, land use, hydraulics, and ...?

Para 4. There needs some additional explanation for what each of these terms mean, how they are 'calculated' etc. While not much is actually said about these, how did the authors expect the reader to interpret them? What is a significant difference?

Para 5. Again, some more explanation is warranted. Is this an adequate test of sensitivity? Based upon the presentation, it cannot be seen that Lake Erie is not affected as the authors should provide a comparison to another figure. For Erie is it Figure 23 to Figure 9 and Figure 25 to Figure 19. How much different would they have to be?

Table 1. A caption is warranted. The text is in French and the text refers to the English quantities. All the terms in the table should be defined as spelled out in full.

Figures 6-26. A lot of space and a lot of ink are given to these without them being adequately described or used. Figures that let the reader make the visual comparison between lakes and terms are needed. Try a figure 5x2 for Lakes with deficit/surplus run length. Another for Lakes with surplus sum. Add some text to describe what the reader is supposed to see in these figures, particularly the latter which is not mentioned at present.

Redraw Figures 23-26 with their comparison figures 9 and 19 to show the differences, or lack thereof, between 0.9, 1.0, and 1.1.

Section D Seasonal Characteristics.

This section should be presented first before the describing the series of annuals.

The text in this section is not clear. For example, Figures 27 to 31 show the monthly variations in net basin supply. Figure 32 and 33 show lag-1 to lag-3 autocorrelation.

These Figures [27-31] need better captions. Does the colour of the lines contain information? Could they be coloured by, say decades, or in relation to change points to be more informative. The addition of the median to these plots would be useful. Consistent scaling would make the comparison easier as well [Superior 12000, Mich-Huron 1.5×10^4 , St. Clair 1000, Erie 6000, and Ontario 5000.

I cannot follow the lag-1, lag-2, lag-3 autocorrelation as presented. Why not simply show the ACF out to 36 periods? Only two of the autocorrelation plots are described in the text. That description is not adequate “**The month to month correlations plot for Lake Superior follows that pattern showing significant values for months August to November (corresponding to the decaying period) whereas Lake Ontario significant month to month correlations go from May to January.**” And does not contain a link to either Figure 32 or 33. What do the author want us to see with lag-12 of lag-3 that would be useful? It would be more useful to have the ACF of all five lakes to a longer period to see the seasonal aspects. Some readers will not get that lags 4, 8, and 12 of la-3 are actually the correlation of a month with itself.

Following this, the authors suggest “These particular and different seasonal characteristics justify our choice of the Julian year instead of usual hydrological year.” This does not follow. A better argument would be that since the water years of each of these basins is different they are being compared based upon calendar years.

Page 27. Spatial Characteristics.

Two sentences do not seem sufficient. The first sentence points to a table; the table contains correlation coefficients [and not cross-correlations]. There is no indication if the correlations are significant, but lakes further away have lower correlations than lakes that are closer together. I note that Lake St. Clair has not been included in this analysis, and the author needs to explain why this is the case. Only the correlations for the series of annual NBS are shown, and not the monthlies. Given the discussion above about the differences in water years

between the lakes perhaps more analysis and interpretation is warranted. While the conclusion seems obvious that each lake be treated separately, the author suggests that 'each lake should be treated as a particular key site for modeling purposes'; this wording is interesting, but the authors should explain what a particular key site means.

Page 28. Concluding Remarks. These could be improved to relate to what is actually shown and illustrated, and why these are important.

Part B Stochastic Modeling and Simulation of the Great Lakes System

General Comments:

While it is appreciated that this is intended to be largely a presentation of results rather than the methods, it currently lacks purpose or direction. Most of the written sections are far too sparse and uninformative. As indicated in the detailed comments below, the text should introduce the figures [or tables] describe briefly in one or two sentences how they were constructed and how they could/should be interpreted. It would be useful to reflect on what the reader should take away from each.

As a reviewer, it found myself asking myself why if there are five lakes being reported on are their only a selection of figures. Were these the best examples, random examples, and why were others excluded? It would be useful for the text to indicate that the selected examples were typical or the basis upon which they were selected.

Figures and their captions. Generally the figures have no captions or uninformative ones. Most of the figures have labels that are some code that the authors might be able to interpret, but these are left to the reader to guess about. It would also be useful to have some clear distinction between 'observed' and simulated figures. One suggestion would be to add shading [say white / grey] or a word mark [observed / simulated] that would make it clearer.

The text refers to figures as X.Y and the Figures are labelled as X-Y.

In addition, it would be useful to group the figures onto single pages. There is a large amount of space and paper being consumed, and in many places the reader has to flip between many pages to visually compare.

Specific Comments:

Global Page 38. suggest you delete this page entirely. I believe that it simply is a copy from a larger report and has no place here.

Global page 39.

Para 1. Sentence 1 need to explain what you mean by poorly synchronized. Sentence 2 is awkwardly worded and should be rewritten so that the reader would have some sense of why it should be expected that sequences should ever repeat. Sentence 3. awkward wording.

Para 2. is 'grasp' an appropriate term? I think not.

Line 5 'This set' – sentence needs to be rewritten as these are not 'potential hydrological scenarios'.

Last sentence – 1900-2000 is 101 years yet the authors use 109 years repeatedly throughout the paper? Later on the page they refer to the 1900-2008 period as the new NBS database, but that only has additional data and is not 'new'.

Para 3. Topic sentence should not begin 'Reference 1' this form of referencing is problematic as they do not appear in sequence and are numbered apparently alphabetically and in mixed forms. Reference 1, 6 and Smith et al. 2005.

Typically, if numbering is used they simply appear as superscripts were appropriate.

This paragraph should be expanded and summarize the methodology to some degree.

Para 4, line 4 'demanded' is likely not the correct word.

Para 5 line 3 'final' should be removed. It would be better to say 'this synthetic NBS series. This would also be a good place to introduce the parameters of that series 55510 years which is 510 series of 109 years strung together.

Line 6. statistical conformity

Line 7 delete 'in a statistical sense'.

Page 40.

Line 1. A reference is made to chapters. It would be best to have the entire report composed of chapters and each chapter composed of sections; or vise versa. There seems to be some mix at present.

The description on page 40 is insufficient. These are not even sentences. It is here that the reader should be getting a clear picture of what will follow an the 'story line'.

Page 41. para 1.

Wording problems 'IDEALLY complies' 'plan makers'. Choose better words and rewrite the paragraph - it is awkwardly worded and unclear. Too much information is left out.

Para 2. This paragraph is weak, awkward, and unclear. '... the 'plan makers' want to model as closely as possible ' The planners want the output of the models to realistically reproduce the '

This paragraph is one sentence. It should be several, and should explain why the marginal distribution of the annual flows and monthly [not seasonal] flow etc are necessary.

Para 3. Again do not begin with "Reference" – "A stochastic NBS model produces a series that"

Para 4. line 3 delete 'one of the ' –"Each statistic of interest..."
"...and the mean, variance, minimum and maximum of that statistic are estimated."

Para 5 " The next section..." deal with 'plan users' and 'plan makers'

Page 42.

"Table 2.1 resumes the annual..." – resumes is not the correct word. Perhaps they mean summarizes?

Table 1.1 [referred to as Table 2.1 four lines previously] should have an improved caption. This should be something like "Statistical characteristics of the series of observed annual NBS to be preserved in the simulated series."

There should be no blank boxes in this table. Replace blank cell with 'none'. It would be useful to the reader if there was some justification provided for why the characteristics to be preserved are selected. Also, these are not necessarily 'temporal characteristics' [lags, runs etc certainly are, but means and variances are not.

There is not mention of long-term persistence, climate forcing, landuse change etc. and these should be mentioned.

These comments also apply to Table 1.2

Page 43.

Paragraphs 1, 2, and 3. These paragraphs need to be written so the reader understands what they are about to encounter. As it currently is written it is pretty exclusionary – you need to be a member of special club to understand this

stuff.” I am a member of that club and still find this text awkward and thin. These paragraphs need to better explain, and better summarize. At one level this text is largely a list of pointers.

Paragraph 2 – needs to be a summary of the selected method. ‘Delete ‘As mentioned in Reference 1 and early chapters. These pointers are inappropriate. This is Chapter 2 – what does ‘early chapters’ actually point to?

Para 3 - all pointers and no content!

Section 2.2

This needs a real introductory paragraph and not another list of pointers. Take the time to explain the sense, but not the details, of the shifting mean model, of CARMA, and how these fit together.

The text here refers to Figure 2.1 which is not located here where it is described but several pages later.

Page 44. This text is all about the noise component and not the shifting mean which needs to be given more prominence and an explanation. The last sentence seems irrelevant; but it is difficult to be sure.

Page 45.

Figure 2.1 and the text below it needs to be presented earlier, and should be incorporated into the description of the shifting means model. The caption is inadequate.

Page 46. para beginning ‘Because of sample variability ...’ is not clear, and needs some additional explanation. When you describe if p is known then logically one expects to see if p is not known.

Section 2.2.2 describe fitting the CSM-CARMA model. Section 2.1 describes the CSM but the CARMA portion is never mentioned.

Paragraph 1 “The autocorrelation ...” is not a sentence.

Para 2 –should this be part of the missing CARMA description?

Needs a clear presentation about the process of fitting the model.

Section 2.2.3

Referencing style changes. This section needs a description of how this fits. The description of the statistical theory is fine, but it excludes many readers, and does not explain how this is being used, or why.

Page 47 para 2. More text that excludes the reader. How will the reader make use of this information?

Note on reading the text the first-time. At this point we have a good guess at the nature of the shifting mean model, no real understanding of the CARMA model [despite rearranging text in our mind; and a method of the model that is described in a fashion that excludes the reader.

Page 48.

The two sentence introduction is inadequate. The second sentence is a pointer to another chapter. What does the author wish the reader to take away from this section?

Section 3.1

Para 1. These are tables not figures. Five pages of Tables of unexplained and un-interpreted numbers are not very useful to the reader. The readers still have not been provided with a clear introduction to 101, 109 years, 510 series, and 55590 years.

Para 2. Paragraph is awkward and missing important details. More text is needed to better describe these figures. Can the 5 pages of plots be condensed to a form where the reader can compare them? There are five lakes but only three are presented – what is the basis for the selection/ Good correlations are mentioned but not shown or substantiated. There are three figures so “Both graphs on each of Figures 3.6 to 3.8 ...” is a problem. Need to explain $p/(1-p)$ effect better.

Para 3. needs to be a better explanation. Two lakes are shown and the other three are not mentioned. It contains opinions and no criteria to base the assessment of the two lakes and certainly not the other three.

Para 4. The text is inconsistent with the figures with respect to left and right panels. Another place to use [a] and [b].

Page 49.

Para 1. This text refers to a figure that is at least 12 pages away. It needs to seplain ‘selected transformation for month..’ The text is unclear and needs to be rewritten to provide a clear statement of what he figure contains, the interpretation of the figures, and how that information is relevant.

Figures 3-1 to 3-5 are actually Tables. They are referred to in the text as Figure 3.1 to 3.5. [apparently this is done broadly]. The table headings are gibberish.

There are not captions, and the abbreviations in the rows of the table are left for the reader's imagination.

Figures 3-6 to 3-8. Captions could be more informative. The fact that there are different y axes need to be pointed out to the reader. It would be useful if the region of right panel [b] was indicated in [a].

Figures 3-9 to 3-12. Caption is inadequate. The left [a] panel is for the maximum, and the right [panel b] is for the minimum. The reader wants to make a comparison to panel [a] of the previous figures, so it would be better to put the left panel on the right and right panel on the left with the x axis reversed. There needs to be an explanation in the text to provide interpretive guidance about the importance of the observed points that do not fall on the line. Would a goodness of fit test help?

Page 62

Section 3.2

The introductory paragraph needs to provide a better explanation. Again this paragraph is mainly pointers and unsubstantiated statements. 'in a previous section' needs to be explicitly stated. "As expected" warrants an explanation. It is unclear what the authors intend the reader to do with the figures they are about to present. This paragraph should indicate that this is about 'observed' or 'simulated'.

This paragraph in part:

- Figure 3.14 ½ of an unclear sentence
- Figure 3.15-3.17 one sentence
- Figure 3.18 – 3.20 one sentence

The effect of choice of calendar year over water years is not well articulated

Figure 3-4. Caption needs to be improved. This is the observed NBS? It is clear that a box-plot [1 or 2 SD boxes?] is not a good choice of distribution. This is one lake, what are the other like, better or worse?

Figures 3-15 – 3-17. Captions incomplete. Figure heading un-interpretable [understood to be file names?]

Figure 3-18 to 3-20. There needs to be a better description of these. The one sentence provided is not sufficient. These are simulated and the reader is expected to the ACF is the first document? The reader has to use too much imagination/guess work. How the authors use lag 1, lag 2, and lag 3 remains unclear. [see previous comments].

Page 69

Para 1 This section presents statistics ...

Para 2 link to the observed series.

Para 3. not sufficiently clear. Does the last sentence describe a constraint of the model.

Table 4.1 which series are observed and which are modelled? How is the change in storage determined – is it 2009-1900? If that is the case then it should not be considered an average statistic. A better explanation of the base case and how these numbers are generated is warranted. Why is average used and not median? What is the sensitivity, or confidence interval of these? Are they taken from a published reference?

Page 70

Para 1. First sentence needs a period following “model”. The authors should have presented this information earlier [with respect to the numbers of series etc]. This description does not seem to be the same as was presented earlier.

Table 4.2 The caption, and the table contents should indicate that this is about connecting channels. Tables 4.1 and 4.2 should be more closely linked. As for Table 4.1 which of these are based upon observations and which are modelled. Some indication of variability would be a useful addition.

Para 2. As in the Historical summary, this section is not sufficiently complete. Figure 4.1 to 4.4 are not adequately presented nor fully used. An experienced statistician would be fine with them, but there really needs to be more detail provided. If you are not going to use all parts of the figure then do not present them. It seems that only the left hand column elements are used, and even those are not adequately explained. The captions to the figures are inadequate. They should describe how each panel was prepared; presently too much is left to the reader to guess. I suggest they be labelled a-f.

The text refers to Figures 4.5 to 4.8 – these are actually tables. The opinion that the statistics are ‘well reproduced’ needs to be explained more fully.

Para 3. In Figures 4.9 and 4.11, the right hand side show non-parametric confidence limits; not the left side. Again, it would be preferable to label the two [a] and [b]. Why switch the historical and the simulated? My suggestion is to always put the historical first and then to compare to it.

Para 4. why are the figures being mentioned out of order? Logically these should be numbered 4.9, 4.10, 4.11, 4.12 instead of written about 4.9, 4.11, then 4.10, and 4.12.

Figures 4.1 to 4.4. These should be clearly linked to the elements in tables 4.1 and 4.2 and also to the similar Figures in the Historical section. The comments made there also apply here. Captions could be improved; figure heading cleaned-up.

Tables 4-5 to 4-8 are Tables and should be numbered as such. Since there are no captions, and there should be captions that explain the contents. For one example, how does one interpret the standard deviation of the standard deviation?

Figure 4.9 and 4.11 put the historical first [on the left] and then to compare to it. Captions could be improved; figure heading cleaned-up.

Figure 4.10 and 4.12 put the historical first [on the left] and then to compare to it. Captions could be improved; figure heading cleaned-up. The problem of clarity around one series of 55590 and all the other 510 series being 109 year slices of that same series needs to be fixed in the text and captured in the captions.

Page 83. Each paragraph on this page should [1] better describe the figure, [2] explain why the lakes shown were chosen instead of others, [3] some text provide that suggests how the figure should be interpreted, and [4] some explanation of why that is relevant.

Paragraph 3. This paragraph deals with figures of historical data [Figures 4.16 to 4.18]. Have any of these figures been shown earlier and are repeated again here. Perhaps here only figure elements that are discussed and described need to be repeated. The authors are leaving too much to the judgment of the reader for these comparisons. Figures 4.19-4.21 are tables.

Figures 4.12 to 4.15. Captions need improvement. Figure headings need to be clean-up and made informative. Many of the headings bear little relationship to the text. For example, where are crmflo and ermflow defined [4.13 and 4.15]. Similar for smmflo, crmflo, and drmflo in this group of Figures.

Tables 4.19 to 4.21. No captions and insufficient explanation. The table headings bear little relationship to the text.

Figures 4.22 to 4.25. Captions need improvement. Figure headings need to be clean-up and made informative. Many of the headings bear little relationship to the text. See previous comments about this. Here they include spmmlv mhmmlv etc. Here again the lower tail is shown on the right and reversed from the first presentation.

Page 99. This paragraph seems to be misplaced. Should it be at the end of this section? It does not seem to follow logically where it has been placed; it seems unlinked and unexplained.

Page 100.

Para 1. The first sentence is awkward and exclusionary. What is this trying to say? In the last line "Annexe 1" should be "Appendix 1". This entire paragraph needs to be replaced with a clear explanation of why the analysis of runs is important.

Para 2. the severity of these extremes is indeed important; the problem is that the severity is a product of [1] frequency, [2] duration, and [3] magnitude.

Para 3 is insufficient. Are we mistaking a pointer for information?

Section 5.2 Para 2. Reorder the figures and the text so that they are parallel. Check the statement that the maximum deficit occurred in the 20's as the 1997-2007 period looks at least as large. It is important for the reader to be able to compare certain of these figures. It would be better to order an arrange them to support the comparisons.

Page 101. para 1. in line 2 the notion of CAR(2.0) is introduced. This model has not been introduced or explained. Again, here the authors need to introduce, present, explain.

Figure 5.1 and 5.2. Caption? Why does 5.1 have 4 highs and 4 lows yet 5.2 have 6 of each? Is this the best way to present the data since clearly the use of box plots is inappropriate for the distribution of data? Also, these so not seem to match 4.14 and 4.15?

Figure 5.3 No caption. The 'delta' used on the y-axis has not been explained. Is this the annual drop in lake level?

Figure 5.4, 5.6 no caption. The text does provide some explanation, but the captions should provide an explanation. Also there seems to be a different number of clines in each of these.

Figure 5.7 and 5.8. remove shading, make the x axis the correct and same length. Why does one have 5000 and the other 5900 runs? Why is one labelled RI and the other Série 1?

Figures 5.9 - See comments in part one regarding these bar charts and the lack of adequate descriptions.

Page 108. This paragraph does not explain this sufficiently well. Explain the difference in lengths of wet and dry spells in the lakes. Are each of these the longest? Seems to be comparing the longest in the simulations without comparing to the observed.

Page 111. These paragraphs do not provide an adequate summary, nor do they explain the findings sufficiently well. There is no discussion. The objective seems to only be to present results and not a pathway that the reader can follow to come to the conclusion that the simulations provide an acceptable set of expected outcomes that will support their use in additional studies.

I think the result look to be very good, but the reader is depended upon for a level of skill and understanding that is not appropriate.

Page 112. The mixed system of referencing was noted earlier. Here references 3, 4, 8, and 9 did not seem to be used in the text of this section.

Appendix 1. This could be incorporated into the text in section 5 and not separately here. It seems odd to induce this much detail about runs of surplus and deficits and very little about the model that generates the series and the methods used to fix them from observed data. Finally, the numbers in the second paragraph do not match the figure.,

PART C – Seidou, Lee and Ouarda

Page 120

Line 2 'potential' performance of a given plan...

Line 4 - that are 'sufficiently' long enough...

Line 5 'sentence starting 'Historical observations...' it does not follow – if the historical data are not adequate, then assuming that longer stochastic series with the same statistical attributes as the historical data will be adequate is a large assumption. Needs additional explanation.

Line 6 - are 'often' too short... and ~~the only remaining~~ 'one' alternative is ...

Line 8 line 12 the authors use 50000 in contrast to the earlier use of 55510 – were these actually done differently?

Para 2 delete 'In this report'

There is a need to provide some evidence and reason for ENSO to be considered. The previous paragraph describe long time series, and this is a jump in logic to including ENSO.

Line 2 non-stationarity

Line 4 50000 synthetic yearly ENSO values were afterward generated ... – awkward wording – normally these would be the 'annual series' not yearly.

Line 7 Sentence beginning 'Finally, noise was generated...' needs additional explanation as to why.

Line 12 none of these three references are listed in the references section.

Line 15 Sentence beginning "The resulting NBS sequences were finally with the ..." is not a sentence.

Page 121

Paragraph starting on previous page. I do not think that the paragraph is very clear. Extracting ENSO from GCM's is not always possible as many GCM's do not resolve ENSO specifically.

Need to clarify the differences between GCM outputs and NCEP reanalysis output. Technically, these are not 'data' but model outputs.

The 'second model' is not adequately specified so understanding the outputs in the bulleted list is not sufficiently clear. The scenarios should be explained prior to their use in this list.

Sentence "These last three time series..." depends on the poor explanation given on the previous page. [120 line 15]. Perhaps it would be useful to add a figure that would explain both of these models better?

Paragraph 2 'The remainder report is organized...' is not a sentence. The English in this paragraph is particularly a problem.

The section on scenarios in this paragraph is problematic. A1B and A2 are but 2 of 40+ equally probable scenarios. Why were these two chosen over the others? Using only two scenarios does not "account for climate changes."

2nd last line on page "...chapters IX (), X, and ..."

Page 122 Chapter II

Paragraph 1 - more pointers without content or connection.

Paragraph 2 – It would be useful if there was some consistency in the naming, acronyms, and order of the five lakes. When the reader faces different usages, it is [1] confusing; and [2] they seek to understand why the order, names, or acronyms are different.

Figure II-1 Caption is inadequate. The figure needs to have a legend to link the lines with the lakes. It would be useful to vary the line types as well as the colour to support greyscale and/or colour challenged readers.

Page 123.

Table II-1 – Caption is inadequate, needs to show units, abbreviations, and other pertinent information that helps the table stand alone. Caption has spelling error. Lake order is different to text on page 122.

Table II-2 – Caption is inadequate, needs to show units, abbreviations, and other pertinent information that helps the table stand alone. Lake order is different to text on page 122 and to the table immediately above it. The numbers in the table would be better without exponents [or at least use the same exponent for each case i.e. 003] to be consistent with the usage in the text. Need to explain the units better.

Line 1. This is not sufficient. There should be some explanation as to why these attributes are felt to be important, how adequacy is assessed and the amount of tolerance.

Page 124 line just before the table "... of the predictors depend of the stochastic sequence..." is not clear.

Table II-3. The caption is not complete. This is more than a list of generated synthetic NBS sequences. It would be useful if somewhere the distinction between 'series' and 'sequences' was made clear.

Page 125

Once again, the technical level of the description provided makes this reviewer question who the intended readers of this report might be?

End of step 2: ' ... and the desire is that the elements of Ω reproduce the temporal ...'

Step 3: the wording needs to be improved, and the time period clearly linked to the availability of NCEP (1949-2008). There needs to be a better explanation of 'adding a constant to each lake's NBS' – it is not clear how this is done; and if this adjustment is made to overcome any difference then how can historical means be considered as a meaningful attribute to be reproduced?

Page 125

Amadou et al 2009 [used several times] is not a listed reference. English in this paragraph is awkward. Net Basin Supply – which NBS is this?

Sentence beginning "50000 values of each of these six potential" is difficult to follow.

In the following sentence should is the "NSO process" non-stationary oscillation or ENSO?

Line 15 "It was therefore decide to develop a NL-ARXmodel..." is not sufficiently described to allow the reader to follow the reasoning.

Last sentence - spelling errors

Paragraph 2 "another Pointers paragraph"

Paragraph 3. wording is difficult. Please explain why it is an 'objective variable'

Page 127

Once again, the technical level of the description provided makes this reviewer question who the intended readers of this report might be?

In 1. it seems odd to list "no non-linear transform" as a form of non-linear transform. And the double negative does not add to clarity.

In 2. need to explain the 'networks'. The link "in section 1" points to where? There needs to be some wording added to explain what this means in a practical sense.

In 3. need to explain the 'networks'. There needs to be some wording added to explain what this means in a practical sense.

In 4. need to explain the 'networks'. There needs to be some wording added to explain what this means in a practical sense.

"a set of inequations" ??

Page 128

Below the W equation there should be some explanation of 'complex conjugate' and 'admissibility conditions'. Since the authors have included them the reader should be informed of what this means in a practical sense.

Figure III-1. Caption is inadequate. An alternate scale that transfer to grayscale would be preferable. Need to explain what the lines within the figure indicate and the boundary [no edge effects].

Page 129.

Figure III-2. Caption is inadequate. An alternate scale that transfer to grayscale would be preferable. Need to explain what the arrows within the figure indicate and the boundary [no edge effects].

Page 130

In this numbered list:

[2] needs to explain the selection of a threshold.

[3] needs to explain the basis for this selection.

[4] clarify this – perhaps in a practical sense this is all non-important components are ignored?

[5] equation 8 is referred to – the only equation 8 that is in this is on page 134?

That equation does not provide the outcome described here.

[6] needs further explanation.

[7] **Figure 2-1 not shown** [is this actually referring to III-3? The clarity of this text will need improvement.

Overall, this description is not sufficient to provide a non-specialist reader with an adequate understanding of the process.

Page 131

Figure III-2. Caption is inadequate.

Wording of the paragraph is awkward.

Table III-1 is it not 'Climate Index' and not "Climate indice". There should be some text explaining the basis of selection of these indices.

Page 132

III.4 First bullet could be more clearly worded. Spelling error.

Third bullet – is this the Nash-Sutcliffe coefficient? Is NS a good [robust] test in this case?

Table III-2. Caption is inadequate. Units? Undefined terms? In fourth column. What are the n's?

Figures 3-4 to 3.8. The referencing of figures and tables is very messy and inconsistent in this section. NASH has not be adequately defined and the reader will have no basis to understand that 0.22 and 0.4 are to be compared to 1.0.

Page 133

Figure III-4. vary line types as well as colour. Caption inadequate.

Where are the figures 3-4 to 3-8? Or III-5 to III-8?

Spelling error in text. In the table below “III-4”

Table III-4 is oddly split between two pages with the caption in the middle?

Page 134

First line Table 3??

A second equation (7) is provided on this page?

The pseudocode section needs to be presented as such.

Page 135

Line 3 spelling error

This reviewer is unsure of the usefulness of “A Matlab script which ...”

Line 9 Table reference is incorrect and there is a spelling error

Paragraph 2 – table references incorrect. Some text to clarify; help the reader understand how to interpret ‘very close’ and ‘of the same order’

Previous comments regarding captions and table structure apply to III-5-III-7. .

Page 136

Need to add a summary to bring these many pointers to figures tables and text to give the reader a sense of what has been shown in this section.

Page 137

The first paragraph is largely a copy for earlier in the document. It contains the same shortcomings. The two differences indicates at the end of the paragraph warrant more explanation.

Paragraph 2. reference to the table should be to a specific table IV-1? The period 1948-2009 is for the NCEP series; explain why the standardized period is

for 1961-2009. Also it is not clear if the standardization is done over lake drainage or over the entire domain.

Further, the 25 variables are either extracted or calculated. The authors should indicate which are extracted and which are calculated. Also they might suggest why these 25 were selected.

Table IV-1. The caption needs to be more complete. While some readers might have a good sense of why these variables might be good predictors for a hydrological model [or a statistical model of hydrology] the average reader might not be clear on why these variables might be useful. Some additional information that would benefit the reader is needed.

Page 139

Paragraph 1. Needs an explanation of the advantages of these forms of smoothing and also address the fact that these are not independent [if in fact the original 25 could be considered independent].

Table IV-2 IV-3 and IV-4– Are these tables referred to within the text? Does the numbering [1-7] indicate the best to least explanatory models? Also, the caption should explain how the encoding in the table can be interpreted. Some parts are likely to do with watershed areas, but “SUP_c3alp5_vna JUN(Y+1) to JUN(Y+1)” is not very informative.

Figures IV-1 and 2. Are these referred to in the text? Captions needs to be more complete. While there are places where acronyms for the Lakes are useful, it seems odd to refer to Lake SUP.

Page 142

Text and table mix reference systems. It would be useful to indicate that the expectation for the residuals is that they should be zero. The problem is that the reader does not have a context for the numbers in the table – is say -121 cms large or small?

Last paragraph – table and chapter references inconsistent. 3rd from last line – spelling error correlatiob.

Page 143

Need to note that the V-COV of the residuals is an order of magnitude larger tht those of the fitted model in table IV-9.

A summary at the end of this chapter would be a useful addition.

Page 144.

Comments made earlier about using one GCM and two scenarios apply to this first paragraph as well. What is the relevance of the statements about the model structures; and the role of governments in running GCM's? It is probably more realistic that the GCMs are run on super computers that are primarily used for weather forecasting supported by government.

How is the popularity of a GCM measured?

Page 145

These two paragraphs are largely repetitions of earlier text. The first contains additional unnecessary text. The use of an average of grid cells as predictors seems at odds with the extensive literature on downscaling. The suggestion that standardized series have the 'appropriate scaling' is debatable.

2nd paragraph. Needs more explanation. The numbers in this paragraph do not agree with those elsewhere in the report [other sections].

This 'chapter' at it exists could simply be deleted; it is largely a repeat of text used earlier, and provides no additional information. With the addition of some information it could provide the reader with some context about GCM's and their use.

Page 146

Delete the 1st paragraph

The second paragraph seems to be in an incorrect location. The authors should be careful to put the information about ENSO and PDO into proper context. How much precision is added by including these indices in the models.

The third paragraph is inconsistent with earlier material that suggests that a stochastic model is the one alternative. Need to specify how 'sustainability' is being used in this investigation.

The text of these paragraphs needs attention to the use of articles.

Last paragraph "Reference not found" is second to last line. Two sentences beginning "To check whether ..." are awkward.

Page 147

Table VI-1. Caption not complete. Most of the footnote should be in the caption.

Page 148

Five lines from the bottom of the page the authors say that 'the difference are small' are they unimportant or insignificant?

Section VI.3

Can be deleted without impact.

Is there any summary that can be made of Chapter VI? There does not seem to be any information of value in this entire chapter.

Page 149

Paragraph 2. Needs more explanation of how the comparison is made and why Weibull was used.

The following section starting "In Section VII.1 ..." is another case of a set of pointers that simply lists items [pointers]. The text about the main conclusion is useful and similar text should be added in many places in the entire report. However, the reader is left to their own interpretation of 'fairly well reproduced' and 'well reproduced'.

Page 150.

None of the figures in this chapter seems to be discussed except being mentioned in the list on page 149. The following comments apply to the first occurrence and each clone that follows.

Figure VII-1 the x-axis should list all the pairing and not leave it to the reader to guess the missing labels on the x-axis.

Figure VII-2 This form is 3x4 and later [VII-8] the form is 4x3. Each component should have a label.

Figure VII-5 Is this the best way to present this information? What are the units? The observed data is only a single point and being compared to model output with wide confidence intervals. It would be interesting for the authors to provide some interpretation that would assist the reader in interpreting this specific figure.

Figures VII-6 and

Caption is not correct the observed data is a + and not a o

Page 156.

It would be useful at the end of this section to provide an interpretation of whether or not the 'validation' is acceptable.

Page 157.

The comments that were made on pages 149-156 apply to this section as well.

In figure VIII-1 the circle is not very visible.

In figure VIII-2 [and VIII-6] the observed data is not a o but an x.

Figure VIII-8 needs units. The mixture of y-axis scaling is not useful; better to use one scale to show seasonal variation.

It would be useful at the end of this section to provide an interpretation of whether or not the 'validation' is acceptable.

Pages 162 to 169

These chapters [IX and X] start with a list and a few plots with no interpretation and not summary and insufficient guidance to the reader regarding do-it-yourself interpretation.

Page 170.

Figure XI-1 is too small to be legible. A line [instead of dots in each] for the observed would be better. The caption should explain the manner in which these box and whiskers are constructed as it is different to previous.

Page 174. An interpretation and a summary is needed for this chapter.

Page 175. A summary for this section is needed.

References

Could not find where Torrence et al 1998 was cited.

There were several citations in the text that are not listed here:

Amadou et al 2009.

Stedinger et al 1995

Salas et al 2006

Lee et al 2011

Part D Predictability of climate indices with time series models

General comments

This Part was the best well written of the four parts. While it is clearly written, it perhaps overstates the case for climate indices by relying on in preparation manuscripts and insufficient references to existing literature on climate indices and the Great Lakes.

Specific comments

Page 184

It seems odd to have separate acknowledgements in each section of this report.

Executive summary

The objective of this study is to project future climate indices that affect the Great Lakes system Net Basin storage.

Line 7. Need to explain how much prediction improvement the 'most significant teleconnection' provides.

Page 185

Paragraph 1. The climate system is teleconnected to the hydrology; the indices are a measure of the climate system.

Last sentence – awkward. I am not sure what is intended.

Paragraph 2.

...these climate indices can be used to improve predictions of the ...

Last two sentences. This is not true. The outputs from GCM's are widely available to the general community, and while doing your own GCM would be very expensive, using the output from the available ones is not. Since this is not prohibitive, the authors should consider why predicting the indices in the manner suggested would be better than outputs of GCMs; particularly considering that these physically based models do not always resolve ENSO or PDO.

Paragraph 3. Last sentence – what is the value of stating this?

Paragraph 4. This reviewer finds it difficult to understand how the PDO has a larger signal than the AO, NAO, or AMO on this region. The literature upon which this is based and any supporting analysis would be a useful [and a necessary addition]. How much improvement in the prediction is being gained?

Page 187.

These sections are nicely written and relatively easy to follow to a semi-expert. However, consider who the readers of this report will be. I think that it would be useful to add a 'layman' summary to make the material more accessible to the readership. Perhaps the matrix math can be removed. State clearly the intention,

the context, the process and the assumptions. Also some commentary about whether these are met or not would be helpful.

In the ARMA section, the authors should comment on whether or not it is reasonable to assume that NBS, ENSO, and PDO are stationary.

Page 188

References to Aikake (1974) and Hurvich and Tsai (1989) were not included in the reference list.

AIC is mentioned in an earlier section of this report, but not explained until here.

Section 2.2 GARCH.

Why do these sections not follow the order in which they were introduced in paragraph 3 on page 185?

Note: I found it interesting how much space is devoted to GARCH when the most important models [Part B] are not adequately explained].

Page 191

Why is only GARCH(1,1) used? Is an equation [16] an 'illustration'?

Page 194.

While propositions are important in a statistics paper are they useful in this report? The language alone will exclude some readers.

Page 196.

Note: I found it interesting how much space is devoted to DLM when the most important models [Part B] are not adequately explained].

Paragraph 2. 'cutting-edge' is colloquial. Wording of this paragraph is particularly awkward.

Numbered list:

[1] Was IMF defined previously? It might be useful to have a table of acronyms somewhere early in the report as searching for definitions in a 200+ page report is problematic.

[2] Need to better explain subjective criteria. A reader would not have sufficient information to understand without resorting to reading the original reference.

Page 197.

Bullet [4] “One of the k time indices is selected”. This nomenclature is difficult as we are reading about a time series of a climate index that itself has a time index.

Page 198

Paragraph 1. The point has already been made about the issue of teleconnection. Here, the authors are using a reference to an in preparation manuscript as the sole reference for selecting ENSO and PDO.

Paragraph 2. This is not sufficiently clear, and does not show the logic for selecting this one ENSO index over the many that are available. Including text about “the fundamental tropical atmospheric bridges” as a support is not convincing. Why should that one index be better or best?

A note on the PDO: the first principal component of Mantua et al is not consistently the leading PC. It switches on occasion to PC2 for periods of time – see “Victoria Mode” which makes it problematic if you model only PC1. See Fleming 2009 Can J Physics.

Page 199.

Paragraph 1

Another change in the style of pointing to tables and figures.

Line 5 delete ‘evident’

The last three sentences are awkward and do not seem to follow logically.

Paragraph 2.

Perhaps “We tested many models, but only the following are presented:”

Page 200

Paragraph 1. last sentence . Where is this ‘section 2’??

Paragraph 2. It would be better to state that correlation and RMSE were used to assess the models rather than simply being ‘estimated’.

Paragraph 3. “Out of all, EMD-NSOR model was the least performing one” is awkward. ‘The EMD-NSOR model had the poorest performance.’

Paragraph 5. ends with “..”

Page 201

Interesting that ARMA(28,0) had lowest AIC. What is the resolution of AIC that is important? Table 6 should only show small percentage differences.

Section 5.2. There are data quality issues with the PDO index in the early years that should be noted.

Page 202

Is it necessary to present the same information in tables and figures?

Summary. The first sentence is arguable in general, and has not been adequately shown for NBS. The authors should consider alternatives such as skill scores when assessing their 'predictions'.

Page 203.

The final sentence seems unsupported in this report.

Tables:

Captions could all be improved. The use of bold and italics needs to be explained.

Figures:

Figure 4. Is this not a 'smoothed' spectral density as indicated in the second part of the caption? How much smoothing?

Figure 5.

The individual components should be labelled [Jan:Jan] etc.

Figure 6-9.

These all should have x and y axes with appropriate scales.

These same comments apply to the second set of plots.